

Journal of the Royal Society of Arts

NO. 5012

FRIDAY, 13TH SEPTEMBER, 1957

VOL. CV

CAPITAL FOR SCIENTIFIC DEVELOPMENT THE PROBLEMS OF ITS SUPPLY FOR INDUSTRY

A CONFERENCE

convened by the Royal Society of Arts to consider some of the implications of a Report by Professor C. F. Carter and Professor B. R. Williams entitled Industry and Technical Progress; held at the Society's House on the morning and afternoon of Thursday, 27th June, 1957

Opening Address by the President of the Board of Trade	Pages 824-8
<i>Introduction</i>	
The Science and Industry Committee: its Aims and its Report	828-33
<i>First Discussion</i>	
The Case of the Large Firm	834-43
<i>Second Discussion</i>	
The Case of the Smaller Firm	844-53
List of Organizations taking part in the Conference	854

THE MORNING

RECEPTION AND OPENING

The delegates were received by Mr. A. C. Hartley, C.B.E., B.Sc., F.C.G.I., M.I.C.E., M.I.Mech.E., a Member of Council of the Society and Chairman of the Conference Committee. Dr. R. W. Holland, O.B.E., M.A., M.Sc., LL.D., Chairman of Council of the Society, took the Chair.

THE CHAIRMAN: It is my very pleasant duty to welcome the delegates to the Society's House this morning to take part in this Conference on 'Capital for Scientific Development', and to say that we count ourselves most fortunate to have with us to open the Conference the President of the Board of Trade, Sir David Eccles. We

are most grateful to you, Sir, for finding time from your many duties to honour us in this way.

The Royal Society for the Encouragement of Arts, Manufactures and Commerce has from its establishment particularly interested itself in the practical application of new scientific and technical knowledge. It was, therefore, with especial satisfaction and pleasure that it accepted the kind invitation of the British Association for the Advancement of Science to join the Science and Industry Committee appointed by the Association to enquire into the application of scientific research to industry. The Report of the Committee's enquiries has just been published, and the purpose of this Conference, and of the British Association's Conference at Leeds on the 5th July, is to bring the results of the Committee's work to the notice of those most interested. The Report discusses several important questions and each of them merits very full and careful study. However, the Committee and its sponsors, the British Association, the Royal Society of Arts and the Nuffield Foundation, considered that immediate attention should be focused on two of the most important problems: the supply of capital for scientific development and the supply of scientists and technologists for industry. It was decided therefore to hold a joint conference in two one-day parts. The first part was to be arranged by the Society to discuss the financial question—and that is why we are here to-day. The second part arranged by the British Association is to be held at the University of Leeds on the 5th July to discuss the problem of scientists and technologists.

We shall hear more about the Science and Industry Committee, its aims and the Report, later in the morning, but there is one important point which I should like to stress at this juncture. It is that the Report, as the authors have so generously acknowledged in their foreword, is the production of the whole Committee working as a team. Its members have taken an important part in the investigations and enquiries which have been made and in the analysis and consideration of the results; and we are most grateful to them for their efforts.

The preparation and publication of the Report has been financed partly from grants from the Board of Trade and the Department of Scientific and Industrial Research under the Conditional Scheme for the use of counterpart funds derived from United States Economic aid, and partly from funds provided by the Nuffield Foundation. It is fitting, therefore, that we should have with us this morning Sir David Eccles, President of the Board of Trade, to open this Conference. Sir David needs no introduction from me, for in the high offices he has previously held he has shown an awareness of the important problems facing him and has dealt with them with vigour and enterprise. That he is equally aware of the importance of scientific research to industry and of the need, as the authors of the Report have put it, to 'exploit the natural resource of the brains' of this country, is demonstrated by his recent success in interesting the Italians in the peaceful products of the brains of our atomic research scientists.

It is, therefore, with great pleasure that I have the honour now to request him to open the Conference.

OPENING ADDRESS

BY THE RIGHT HONBLE. SIR DAVID ECCLES, K.C.V.O., M.P.

President of the Board of Trade

I do not think there is any building, and certainly no hall, in London that I enjoy visiting more than this one. It has a charm of its own and anyone who is allowed to speak here is very privileged.

I should like to begin by a Midsummer bouquet of congratulations. First, as the Chairman mentioned, we must be grateful to the United States Government for the Conditional Aid Fund, an imaginative idea. Second, the Science and Industry Committee are to be congratulated for having a dip at this fund and for making their study one on Industry and Technical Progress. Third, a small bloom to the officers of the Board of Trade for having backed the raid on the fund. (They tell me that from the very first my predecessor was most keen on this and I am sure that he must be very glad to see the result.) Fourth, a very large blossom each to Professor Carter and Professor Williams for a book which, I am sure, is going to do a very great deal of good. And fifth, a grateful acknowledgement to the Royal Society of Arts for calling the Conference here. Now I have done my formal duty.

I like very much the modesty and candour of those parts of the book which I have been able to read. Obviously our two authors here have plenty of ability, but they do not pontificate. That is a wonderful thing for an economist. If only more clever men like themselves would not think it undignified to repeat—and, indeed, insist upon—the obvious, how much more easily could we make the best modern use of the truths which our fathers discovered, and how much more easily could we adapt this country's immense experience in industry and finance to the circumstances of our age! I should like to give an example of what I mean. If you take a very respectable and very ancient proposition, 'to him that hath shall be given', and translate it into the context of this Conference, it becomes 'the larger your resources, the easier it is to borrow'. That is one of the facts of life; and the Professors do not ignore the facts of life. I am very glad to see that their studies have not supported some of the wilder notions that are going about on the subject of British industry and science: for instance, that we are highly superior in fundamental research but extremely backward in applying research. I am very glad that they have exposed that one. My own observation led me to think that our weakness lies somewhere else. We do not pay enough attention to money, that is, to the cost of our applied new processes and machines. I do not think we respect pounds, shillings and pence quite as much as we should. I dare say the politicians are partly to blame; we often hear some of them talk as though it was a sin to count the cost of any improvement where the social services are concerned. Time and again I have heard people get up and say, 'Oh, we cannot afford *not* to do' this or that. That is a slogan for bankruptcy, which as I remember very well can find its way into business as well as into Westminster.

I also think that the teaching of mathematics in our schools is a national source of weakness. I did what I could when I was Minister of Education to start to get it right, but it will take years to improve—if it ever does. Mathematics is the foundation of knowing whether it is worth doing something or not in the field of business, once the scientists have said you can if you have got the money. If boys and girls leave school with a good knowledge of mathematics they can turn their brains to almost anything; but if they have only learnt what I call the glamorous side of science, then it must be very difficult for them to understand

what the bread and butter world is all about. Anything that we can do to improve the teaching of mathematics in our schools we should certainly do.

A good scheme for improving the technical possibilities of industry is not enough by itself even if the money to finance it is available. It is then necessary to explain the scheme to all concerned: to the managers who have to operate it and who ask for the money; to the shareholders who may have to accept lower dividends for the time being; to the public who may have to put up new money.

Let me explain why we should take trouble to explain that the cost must be borne to-day in order to earn more to-morrow. Unless one faces that fact at the outset one merely encourages people to react with their hearts instead of their heads, and to approach in an emotional way propositions for improved techniques and new machines. They feel rather than understand. In this respect the Report should be of great benefit, because if it is read by managers and by Trade Union Leaders as well, it ought to help many people to think more clearly about industry and technical change, and to dissuade them from accepting generalizations which are often much too broad, and which they would see from the Report are very often a long way from the facts as revealed by the case studies.

The chapter about new capital emphasizes the constant danger of confusing the channels of supply with the supply itself. In the past the great question has been whether the channels were adequate to the borrowers; but, of course, times have changed, and the master problem to-day is the fact that the savings of the whole world are hopelessly inadequate for the formulated investment needs. Plans that actually exist could be carried out if the money were there. Sixty years ago almost to the day occurred Queen Victoria's Jubilee, when the 3 per cent Consols were well over par. The $3\frac{1}{2}$ per cent War Loan is now under 70 and the problem that faces us is not, as it was in Queen Victoria's day, to find outlets for a superabundance of savings, but to find the savings for a superabundance of outlets! That difficulty must push any Government and industry into quite different policies, and I hope you will consider those.

There are, I believe, three sources of capital. First, there is the budget. A society that has nationalized industries cannot avoid using the budget as a source of capital for scientific progress. We cannot pledge the assets of the coal mines and borrow against them because they belong to the State; and the coal industry, for example, cannot really show, and is not likely to show, very large profits. Therefore we are in some difficulty about raising new capital for one quarter of the industry of this country, and we are bound to contemplate the budget as one of the sources of capital for scientific development.

Source number two is profits retained by industry itself, which I should like to say more about in a minute. Source number three is private savings. What worries the Chancellor of the Exchequer is whether, when the public sector has had its cut from all three of those sources, there is enough left for the private sector. Do we get the balance right and does the right borrower in the private sector come away with a loan? There is also the problem of financing overseas developments and meeting the demands of the Commonwealth, which are many times what we can afford.

Then about taxation: I agree with you that company taxation is probably less of a deterrent than some people think; but the trouble is that it does matter what people think, and unless you can remove their apprehension, taxation at any level will have a serious effect. I think it already does. I do not know exactly how you will treat the subject of taxation, but I am convinced of the need for stability in this business. We must try, for example, to avoid chopping and changing the investment allowances. Otherwise a great deal of trouble will be caused in industry. What is needed is a stable policy by which Directors can look forward for a number of years, and by anticipating the kind of taxation likely to be imposed can make their arrangements accordingly. Changes often do a great deal more harm than we politicians realize.

One more thing about capital for industry. Partly as a result of taxation, partly owing to the Welfare State and to a general feeling of great social security in advanced countries, the supply of private savings may never be what it used to be. Therefore the retained profits in industry become much more important, and if you look at the percentage of profits that British companies are retaining to-day compared with what they retained before the war it is not surprising that they are very much greater. The other day the Chairman of one of the greatest businesses in the United States said to me, 'we are getting very short of risk capital in the United States too'. I said, 'I did not know that—are you?' 'Yes', he said, 'take my business. We have a turnover of \$4 billion a year, and I have come to the conclusion that I can only go to New York once every five years, and I get three or four hundred million dollars when I go. That is about as much as I can do. Therefore I asked my colleagues what we should retain. We have come to the conclusion that if we are to keep up our scientific and technical progress we must retain 10 per cent net after tax on the capital employed in the company at any time. That is a lot of money, 10 per cent after tax, and there are several kinds of people who would like to have some of it, for instance the shareholders and our workpeople. So I was faced', he said, 'with the question of how was I going to get this policy accepted by my shareholders, by my workpeople, and by my customers also, because obviously I have to have reasonably good profit margins.' So this American businessman started a campaign in his company to educate the shareholders, the workpeople and the customers which was successful. I asked him how much he spent on his campaign. The answer was \$56 million. That figure is worth thinking about. Fifty-six million dollars spent on educating the workers and the customers in that vast company to the view that it is necessary for you to retain the profits at a steady 10 per cent so that the Board can plan ahead and keep in line with industrial progress. When you talk about the big company this morning, and about savings, it is worth considering the publicity that has to be done in order that a steady retained profit should be understood by everybody.

Later you will discuss the small company. I am very glad they are getting a half day all to themselves. I should think that they would be more or less all right were it not for the credit squeeze. I do not know. I mean that the channels through which the small man can get the money are not too narrow normally,

but with the credit squeeze of course the banks are limited. That has to be so because we cannot afford a rise in production in this country unless we can match it with exports. But there is always the man who says he cannot get the money. I often wonder how often the really genuine man fails to get the money, but you will know more about that than I do.

The Board of Trade is very grateful to the authors and sponsors of the Report. They are very grateful that you have arranged this Conference. I hope I may be allowed to read its proceedings. I am a great man for arguments. It would be a very good thing if business and everybody else argued hard with the government about various policies. In this country we tend to be a little too polite and it is a good thing to have a good hard public argument. I shall always be grateful in the Board if any section of industry or economists would point out our mistakes. It is very good for us. If that is the sort of thing which derives from this Conference we should be very glad. These remarks of mine are intended to preface the opening of a serious discussion.

A vote of thanks to the Minister was carried with acclamation.

INTRODUCTION

THE SCIENCE AND INDUSTRY COMMITTEE: ITS AIMS AND ITS REPORT

BY PROFESSOR B. R. WILLIAMS AND PROFESSOR C. F. CARTER

*Directors of Research to the Science and Industry Committee and joint authors of
its Report*

THE CHAIRMAN: We propose to discuss the question of 'Capital for Scientific Development' as relating to large and small firms separately, as the problems which confront these two types of organizations are not necessarily the same. As, however, our discussion stems from the Report of the Science and Industry Committee and from the problems of applying scientific research to industry generally, we find it desirable in the first instance to have a look at that Report, because many of you may not yet have had an opportunity of reading it. Professor Williams is therefore going to give us some account of the Committee and its Report, and he will be followed by Professor Carter, who will discuss briefly the financial sections of the Report.

PROFESSOR B. R. WILLIAMS: The Science and Industry Committee was set up to study the factors which help and the factors which impede the rapid industrial application of science. Part of that study is outlined in *Industry and Technical Progress*. The Committee is now engaged in thinking about what should be done to speed up the application of science and technology.

The Committee was set up at a meeting of the British Association in 1952. Many scientists had felt either that businessmen were not using their services (or not using them properly), or that the British scientific effort was unbalanced—that rather too much energy was put into pure science and rather too little into applied science. Economists also were concerned about the relation of science to industry. In the field of international trade the big expansion was in the

products of the newer industries which were based on applied science, but in the '30s Britain had been slow in getting into those industries. Further, there was a great need for her to expand exports quickly after the war. So we set up this Committee. We thought it would be a fairly simple job: we would ask the people who knew, and collect pieces of evidence, and then we would make a report. But we very soon found that there were more views than people, and very little hard evidence. It was at this stage that we were able to get money (from Conditional Aid Funds through the Board of Trade and D.S.I.R.) to finance an investigation and that the Royal Society of Arts and the Nuffield Foundation agreed to join with the British Association to broaden and strengthen the Committee.

We decided to study the problem by going to the firms that were or might be concerned with applying science. We made a careful study in many firms and industries of problems and solutions; of successes and failures.

Anyone who has had anything to do with investigation of this kind knows how the reports get written. Certain people do the work and certain other people write up the results! In this connection I should like to thank three sets of people. First, the Committee. The Committee has on it many distinguished businessmen and scientists, and they not only helped with case studies, but in the writing of the report they were able to keep 'academic economists' like Professor Carter and me on the rail! Secondly, the research staff. They were a very devoted and intelligent body of workers; they worked very long hours, both in collecting the case material and in sorting and arranging the material to uncover its significance. Finally, the firms themselves. They were extremely generous in the amount of time they gave to collecting material, making it available, and discussing it with us.

I want now to emphasize two or three things in the report which will help set the context for to-day's discussion. The first thing, which is well known to all good directors of research, is that innovation in industry, using the results of science and industry, is not simply a matter of buying a scientist or two and giving him some back room. It is easy to find research projects—there are thousands and thousands of problems which research workers could be set. It is difficult, however, to choose those which are most relevant to the firm's work—that is, most relevant to the production potential of the firm, to the financial strength of the firm, to the sales capacity and to the sales opportunity of the firm. That relevance cannot be judged unless the research workers are kept very familiar with the production and sales problems of the firm, and unless production and sales people are kept very familiar with the work of the scientists. Unless in other words their efforts are in some sense integrated. Equally, eagerness in production departments to use the output of the research department is not likely to be great unless there are close working relations between the various departments of the firm. In other words, we must think of successful research and development as a management technique. Once research and development becomes a management technique the old division in industry between 'scientist' and 'businessman' will largely disappear.

The use of research and development as a management technique is one of

the characteristics of progressive firms. In one of the most important chapters of the book—Chapter 16—you will find a list of characteristics of these progressive firms.

The next thing I want to emphasize is the importance of the relations between firms. One can think of any firm in three senses: first, as a customer of other firms, secondly, as a supplier of other firms, and thirdly, as a competitor or potential competitor with other firms. What any firm can do or is pressed to do in the field of innovation will depend very largely on what sort of help or stimulus it gets from its customers, its suppliers, and its competitors, and it is this chain of relations between firms that plays in many ways a dominating part in the speed or the slowness with which firms in any country apply science to industry. This chain of relations will specially exercise our minds when we come to remedies. For we find strong evidence that backwardness tends to be self-perpetuating.

The next thing I want to mention is the critical importance of the quality of management. Unless the management is energetic and capable, opportunities provided by scientists or provided by suppliers will be wasted. This quality of management is particularly important in a country such as this, which is pretty short of scientists and engineers. Unless management is good our small supply of scientists will not be well used. We have stressed in the Report that the quality of management and the supply of scientists and technologists is on the whole at the moment rather more critical than the problem of finance. I do not want to suggest that the problem of finance is unimportant. We do mention—Professor Carter will say more about this—the special importance of finance in new firms or with really new and strange productions. It is with these that the problem of finance is likely to be most acute, and if we can ensure that these new firms and these new forms of production get the finance, then we will be doing a great deal to ensure that the chain of relations between firms is such as to encourage rapid innovation.

In any case—and I want to stress this to avoid misunderstanding—when we say that the crucial problem in British industry at the moment is not so much finance as the quality of management and the supply of technologists, we are saying something which we judge to have been true in the last three or four years. But of course problems change. If we improve the supply of scientists (and there is already some improvement); if we improve the quality of management (and in particular, if we improve the management of scientists in industry); then the nature of the critical shortage will change. I sincerely hope that soon the critical problem will be the financial one. For then we will know that we have largely solved the problems of the supply of scientists and of the quality of management.

PROFESSOR C. F. CARTER: I should like before turning to the financial aspects of the Report to underline once again the thanks which Professor Williams and I both feel should be given to our research staff and to the Committee, which was an active body. We feel a little guilty that our names should appear on the cover of the book when we should really cover the whole jacket with the names of about thirty people.

The Report does at many points stress the importance of a proper assessment of the costs of new projects. But nevertheless I think that some of those who have read our chapter about the finance of development may have felt that we have rather under-estimated the importance of financial factors. When we were making our preliminary survey we found that there were quite a number of people who were ready to say that the question of finance was uppermost; that by far the most important, and, indeed, almost the only thing holding back British industry, was the wickedness of Governments in denying the money necessary for development. This view is untenable. You only have to look round to find that there are many firms which are not notably progressive, yet, whatever is the reason for their unprogressiveness, it is certainly not lack of finance. They are what I describe as stagnant pools: motionless, but liquid. So finance cannot be the sole ground for unprogressiveness. But our most important conclusion is this: that even though in the period of our study the question of money may only have been important in a minority of the firms, there certainly were those which had a brake set on their development by the difficulty of retaining enough money in a period of high taxation, or by their own inability or unwillingness to raise money from outside; and these firms included some which from a technical point of view were highly progressive. Our sample is small, and very widely spread over different industries and different kinds of firms. We have no desire to rest any firm statistical conclusions on it, but what we found was that of the 138 firms for which we had relevant information there were 19 or 15 per cent which one could say were definitely subject to some financial difficulty. That may seem rather a small proportion, but it is an important proportion, because several of these 19 firms were highly progressive and several of them had been undergoing a period of rapid expansion and had, so to speak, outgrown their strength. Furthermore the financial pressure of the credit squeeze has certainly become more effective as time has passed, and if we had been able to visit some of the firms that we saw in 1954 and 1955 during last year or this year I think we certainly would have added to the list of those who are held back by financial difficulty. This therefore is a problem which though it may not affect more than a minority of firms, yet affects an important minority.

I should like to say just a word more about the nature of this difficulty. It is partly one of retaining enough profits. There may perhaps be shareholders who cannot be disappointed any longer; it may be simply that the burden of taxation takes too much, in competitive markets, to leave enough to finance a new development. But of course the traditional answer is that those firms which cannot finance new development should seek to raise money outside. Some would claim that they have not been able to do so or at any rate find that they are only able to do so on terms so onerous that they do not think it worth while. But what is more important and probably more significant, especially in relation to our discussion this afternoon, is that there are quite a lot of firms which are not *willing* to raise money from outside because they believe in the maxim that 'he who pays the piper calls the tune'. They believe that they will have to

give up their independence; the consequence being, in the case of a firm which is still effectively under family control, that this will mean the end of the family's dominance, and in the case of the rather larger firm that the present board will have to accept new directors appointed by those who have the new financial interest; and in both cases that established ways of doing things will be upset. There are various other fears, some of them vague, some of them not very well grounded, which make firms reluctant to look to outside help for new money, and indeed sometimes to be quite ignorant of the source from which they could obtain such money if they tried.

The financial restraint which is felt by firms (and which is being increasingly felt because of the credit squeeze) is not of course simply a matter of the cussedness of governments. We do make in the Report a remark which is really painfully obvious (but people will keep on forgetting it) namely, that the things which seem possible to an individual firm, which, if it gets more money always hopes to attract resources from its competitors, may be quite impossible if everybody tries to do them together; and that the financial restraint is due to the inability of Britain to do simultaneously all the things that it wants to do both in terms of building up its production for the future and also in having a high standard of living now. This inability we should not take as being entirely a bad thing, because it is in fact the pressure of our desires upon our limited resources which has enabled us ever since the war to maintain substantially full employment. Therefore it is not particularly helpful merely to say that finance ought to be easier and taxation ought to be lighter. One has to know what it is that is to give way to the purposes which you are proposing to favour by making finance easier. It does seem to me relevant to enquire whether, given the enormous importance and value of speedy technical progress, the restraining influence upon that progress is really made as light as possible. Of all the influences which affect technical progress, finance is much the most easily regulated. We can do practically nothing to increase the supply of first-class brains; we can only slowly add to the number and improve the quality of highly trained technicians and managers; but the Chancellor can vary his financial and budgetary controls with very little delay. So this is, so to speak, a key instrument in the regulation of the economy and a means of speeding technical progress.

In its broadest terms the problem is this. Is the supply of savings as high as it can reasonably be made by inducement or compulsion? Is our financial machinery such that these savings are available to those with the best claim out of the queue of investment borrowers? These are two questions which raise many issues; but I propose in conclusion to ask a series of questions, releasing about eleven hares. I am not suggesting that subsequent speakers should necessarily chase these particular hares, but it will at least give you something to be talking about over a cup of coffee.

The first: is there the right balance between compulsory saving through the budget surplus and voluntary saving? You see, if you want a budget surplus you have to have high taxation; if you want voluntary saving you need to have low taxation. So that these are inconsistent purposes. Are we trying to do too

much by compulsory and too little by voluntary effort or is it the other way round? Second: is it good or bad for technical progress that so much capital investment should be financed from ploughed-back profits? Again, it may be a necessary feature of the present day world, but does it mean that there are important new developments held back because they are not taking place in firms that have got the profits to plough back? Does it mean that the industrial machinery of the country becomes set in a certain pattern and not easily changed? Third: are the inducements and privileges given to private savers (e.g., the tax allowance for life insurance) sufficient, or could a useful increase in private saving be obtained by further inducement? Fourth: is there a need for selective means of encouraging specially productive investment (for instance different tax allowances for different industries)? Fifth: what is the place of general measures, such as the investment allowance? Do they lose their efficacy if they are frequently changed? (The importance of stability must be set against the very great importance to government of being able to vary the financial controls to suit varying circumstances.) Then again, is there a better way of controlling fund-raising from the markets than the present Capital Issues Committee? Would it be better for technical progress if capital were rationed entirely by price? We have got to remember that whatever Consols were standing at when Queen Victoria was alive, many European countries have in recent years had rates of interest much higher than our own. We should not ignore the possibility that this is the right thing. Then again, is there any better way of ensuring finance for small companies which unite technical progressiveness with business competence? That is a matter upon which the speakers at our afternoon discussion will be able to help us. Can we make better use of the back-room boys with ideas, but no great ability in finance or sales—people who at the moment are dependent upon finding a right industrial environment to which to link themselves? Can anything be done to lessen the inhibiting influence of death duties? These, as we suggest in our Report, are a burden which tends to make people take a short view because they have to pile up cash to meet the expected duties when they come. Can anything be done to allay the fears of small firms which inhibit them in seeking outside finance—the fears that the City is inhabited by a race of men so clever that it is dangerous to get into their clutches? And finally, a specialist question, but I think rather an important one. The National Research Development Corporation exists as an instrument of the State in giving certain types of support to development. What is the place of that body in the financial support of key developments? Could it extend its scope and give additional help at the points at which the industrial system is most in need of a change?

If in the later sessions you have any criticisms, or questions to ask, about our Report, Professor Williams and I will be delighted to have the criticisms and will do our best with the questions.

FIRST DISCUSSION

THE CASE OF THE LARGE FIRM

THE CHAIRMAN: This session of the Conference will now consider the financial problems of the large firm when it wishes to finance a policy of scientific development.

Lord Dudley Gordon is well qualified to speak on this subject, for he knows both sides of it; not only that of the firm which needs finance for its development, but also the firm which can supply these needs. In addition to being Chairman of J. & E. Hall Ltd., and of Hadfields Ltd., and a member of the Executive Committee of the British Iron and Steel Federation, he is also a Director of Barclays Bank Ltd. and of the Phoenix Assurance Co. Ltd. He is also President of the Iron and Steel Research Federation, and is a prominent member of the Federation of British Industries, holding, among others, the office of Chairman of the Finance Committee. Until recently he was a member of the National Production Advisory Council for Industry.

LORD DUDLEY GORDON, D.S.O. (Chairman, J. & E. Hall, Ltd., and Chairman, Hadfields, Ltd.): We are faced at once with the attempt to define what is a large firm. There is sometimes a tendency to feel that a large firm is one rather larger than one's own. In Chapter 2 of their report, Professor Carter and Professor Williams have set out a number of definitions, but they have not ventured to define a 'large' firm, though in Chapter 5 reference is made to the 375 largest companies with 5,000 or more employees. In one classification of which I know, 2,000 employees is taken as a qualification for a large firm. But I have heard a director of a firm employing over 5,000 say, 'We are too large to be small and not big enough to be large'. Perhaps for the purpose of this discussion a large firm might be taken as one which has a fully established Research Department. The report gives the following classifications:

1. Large firms with their own Research Departments.
2. Firms with few scientists.
3. Firms with no scientists.

On the other hand, there are firms which can be classed as large and have adequate financial resources which have no section which is labelled 'Research Department', but have perhaps a 'Technical Department' engaged in conjunction with a Design Department in solving problems arising from new applications and used for the company's specialized products.

Whatever name such a department may have, it can only be completely effective when it is controlled by a full-time executive director who is a member of the Board of the Company. Such a director takes his part in framing the policy of the Company. He must, of course, be fully qualified technically as a scientist and at the same time have that wide outlook and experience which enables him to share full responsibility with his colleagues for the conduct of the business. It is the absence of such a director on the Board which is apt to lead to a feeling of frustration amongst members of a research department, which may arise at times through a feeling that its achievements are under-valued or not understood.

The use of a research department for what the report terms 'trouble-shooting' is a most useful function. In many cases new methods and new products have passed through the stages of research, development, production and sales and only after some considerable time in use by the customer do they develop some unexpected fault or failure. The trouble must be cured as the result of full investigation in the field by the research department, with which sales research should be closely linked.

Comment, sometimes accompanied by surprise, is often made that a new invention or process is made by an individual or a company and that its full development is

left to others. This may often be due not to a failure to recognize the importance of the discovery, but to the circumstance that the firm in question could only develop the process by the creation of a new line of production apart from its normal line of business. The report mentions, for instance, the discovery of silicon iron by Hadfield and its application in the improved performance of electrical transformers. The first transformer made by Hadfield still exists, but he had no suitable sheet rolling mill in his works, so the development was left to others. Hadfield also discovered manganese steel. His main business at that time was a steel foundry, and so it was there that the discovery was fully developed.

A good deal is said and written about the amount of money spent by different industries and individual firms on research, and Chapter 5 of the report points out the difficulty of arriving at any accurate figure; this must be so because of the difficulty of defining where research begins and ends. A dividing line between pure scientific and applied research, development, production and sales research should not be drawn. The same individuals may well be engaged in all these phases, together with close consultation and liaison with the financial department. Even an Industry Research Association such as the British Iron and Steel Research Association quite rightly undertakes a certain amount of sales research; and expenditure on this is part of the total expenditure, which is easily ascertained but might not be included in the research expenditure of an individual company.

The title of this morning's discussion is 'Capital for Scientific Development'. But it seems to me that new capital is normally required to develop the result of research in an existing department. A research department has usually grown with the business and is paid for as part of the current expenditure. Capital expenditure is undertaken to develop schemes devised as a result of research, and the question of the money to finance these developments is discussed in Chapter 13 of the report.

There is one suggestion in this Chapter which I find it hard to accept, namely that a Board of Directors might refrain from increasing a dividend in order to accumulate funds to erect a new factory. Figures are constantly published showing that the amount distributed in dividends is such a small fraction of total outgoings that a variation in the percentage paid involves a negligible amount of cash. What is more likely to make directors hesitate to recommend an increased dividend is the incidence of the distributed profits tax, which was increased twice in six months. The money to meet this charge as well as the money to finance its operations has to be found by the Company from profits which have already suffered income tax.

I will end with two further thoughts:

1. Surpluses shown are not usually available as cash, and new development resulting from research has to be paid for in cash.
2. In addition to finding cash for taxation and development projects and replacements, large sums have to be found not only for maintenance and repairs, but also to comply with the provisions of such measures as the Clean Air Act, the regulations for foundries and other measures, which though highly desirable bring in no increase in earnings.

Thus nearly every major project means the raising of additional capital in some form rather than cash from internal resources. It must not be forgotten that even when a new project is approved, authorities have to be satisfied that labour as well as raw materials will be available. An example is the controversy now taking place as to whether new sheet mills shall be in South Wales, South-West Scotland or Lincolnshire.

DR. W. J. ARROL (of Joseph Lucas, Ltd.): My first point arises from Professor Williams' introduction, and that is the fact that money has got to be earned and research staff should understand problems of production and even of sales. A case has occurred in our own company in which just this has happened: an exceedingly unusual product has been guided by the research staff right through the

stage of development and production, and they are helping the sales staff in actually selling. I do not suggest that this is more than a temporary affair or that it is desirable in the normal course of events, but it has had the result of making the research staff conscious of the ultimate end of their work, of making production staff see that exceptional products can be developed by research staff and eventually sold, and of making our sales staff understand that the more complicated devices they have been called upon to sell need a great deal of understanding. Therefore this case has been a useful one, and has shown how necessary is the collaboration between the three branches in industry of development, production and sales.

Lord Dudley Gordon did mention that in large organizations, research and development may be financed from revenue. This has been the case in the development of Joseph Lucas, and it has disadvantages in that it may interfere with a projected research programme if for any reason revenue drops sharply during any financial year, when there will be many people queueing up for money and none to be found. If this happens it can be most damaging, and therefore it is proposed in future to try to get stability by financing research over a longer period than one year. I raise this point because it is an additional method of financing research not mentioned by the Professors.

MR. W. E. DUCKWORTH (of Glacier Metal Co., Ltd.): Firms will appreciate some guidance as to the proper proportion of their resources which they ought to be devoting to research and development methods if they are to keep abreast in their field, and serve the interest of the country as a whole; also, some guidance on the ratio of resources which ought to be spent on research, and some indication about reasonable expectations of financial return will be helpful. Many firms are concerned at the amount of time which elapses before they start to see the value of the research.

I think also that we must not ignore human capital. As well as giving thought to the actual capital expenditure on plant, British firms might well give some attention to the salaries of scientists. Scientists are being lost by emigration because they see more attractive prospects elsewhere.

MR. L. J. GEORGE (of Ferranti Ltd.): I want to refer to those industries which, because of a shortage of finance, are finding it difficult to develop. When one looks at the amount of finance which is available, or which ought to be available for research and development, sometimes the comparison is made to the whole of British industry. But it is by no means the whole of British industry which finds it necessary either to do this research or to do it as part of its normal development. Those industries which, because of recent scientific discoveries, are likely to show a high rate of growth in the next few years and in which research and development costs are relatively high are only a small proportion of the total of British industry. If you take the amount of finance available to this limited sector the net total amount is nothing like sufficient to finance all the research and development which ought to be going on. Now the President of the Board of Trade referred earlier to the American businessman who said that he found it necessary to devote 10 per cent of the capital employed in his company to maintain the progress that he felt ought to be made. Ten per cent of capital employed after tax would mean that British industry must be making a profit of 20 per cent on the total capital employed. I should very much doubt whether in those industries in which research is so important—particularly the electrical industry—20 per cent profit on capital employed is being made. What I want to pose, therefore, is the question whether we have in this country any organization which is capable of filling the gap between the high costs of research and development and the insufficiency of profits to pay for this. My mind immediately turns to the National Research and Development Corporation. The Act governing the N.R.D.C., I believe, specifies that this Corporation must show a balance one year with another; and as the original Act, I believe, is due for revision in 1959, I presume that a profit

or at least no loss must be shown by that date. Now in many research projects it is impossible to show such a short period return. I am thinking particularly of such things as computers and machine-tool control equipment, which in the long run are bound to pay. The sooner British industry can get rid of this chronic shortage of skilled people by using more capital the better. The difficulty is that there are a great many teething troubles to be got over before such machines have established markets and the exact result may not be known for ten or fifteen years. Some method of guaranteeing funds for research and for development which does not have to show an immediate return is absolutely essential. The history of the N.R.D.C. to date shows that it is quite incapable of fulfilling this task. What I am suggesting, therefore, is a committee or organization, backed by the Government, which should be run as a business but not on business lines. By that I mean it ought to be run efficiently but it should not have to demonstrate its efficiency by carefully preserving its capital or by 'showing a balance one year with another'.

DR. MENZIES (of the Science and Industry Committee): What I was going to say has already been said by the Minister. It was raised by Professor Carter when he said that we cannot train people quickly but we can quickly turn the tap of finance on and off; therein lies the danger of governmental action, but the Minister has already spoken of the great need for stable finance. Whatever the government does we cannot have the rules changed from six ball overs to eight ball overs every few weeks and still play cricket! If there are frequent changes in the rules of finance it is impossible to forecast the financial structure of your research.

MR. M. ZVEGINTZOV (of the National Research Development Corporation): First of all, I should just like to reply to Mr. George's remarks. It is quite clear now that we cannot expect to make an overall surplus in the Corporation in five or ten years, because applied research and development projects take a long time—anything from five to ten years and even longer to mature. They will usually not start paying off under ten years. In the original 1948 Act what is called Section 5 allows us, when we think fit, and when we are pressed by the government to undertake development and exploitation of something in the public interest but which, on our assessment is not likely to pay off and so cannot be part of our normal programme, to apply to the government for money to safeguard us against loss or estimated loss. We have found after nearly ten years' experience that in research, development and exploitation there are really about five stages: original conception; reduction to practice; scaling up to prototype; then scaling up the first justifiable unit; and finally to full-scale production and sales. These processes take a long time and the cost goes up at each stage. Therefore increasingly selective judgment of the exercise at each stage is required. There are always far more scientific ideas in the earlier stages than can possibly become available immediately or even in ten years; consequently I am very much impressed by what the Minister said, that we must select which are ultimately the most important resources in this country for economic and industrial development. That means that we must have some sort of economic assessment. Unfortunately, in quite a number of technological fields you are dealing with the unknown and the unknowable until you have spent quite a lot of money. In some fields it may cost a few thousand pounds to find out the unknown, in others, it may cost a quarter of a million. Now there comes the great problem of the available finance. It might well be that in the case of a particular industry in which a major step must be taken it may be necessary to spend a quarter of a million on the unknown. Many firms in a highly competitive field have not got that available ready cash to risk; there may be half a dozen items to choose from, but they have got to plump for only one, or two at the most, of several possible steps forward, without any sort of guarantee until they have spent quite a lot of money that it may be commercially valuable. This is where we as a Corporation can come in. This is really trespassing on the afternoon

discussion, and I will have to concentrate on firms which have not got the available cash. In many of our traditional industries which are facing world competition, and probably a static home market, there is not the glamour to attract new venture capital, and the risks of course are very great; but, nevertheless, a really major step forward might change their whole competitive condition. Now we strongly feel in the Corporation this is where the Research Association movement has a great part to play; but the Research Association have only their programmes of research which they bring up to a certain stage—they have not got available funds for tackling vigorously any particular item which shows possible commercial promise. We are trying to work in partnership with these Associations. When an item of their research looks like a promising starter and may require, say, tens of thousands of pounds, or more, to take further, we try to organize a 'combined operation' of the Research Association with, say, one or more firms in the industry, and ourselves to provide the 'missing components' of finance for such a venture into the unknown. If the thing is a failure we have all lost money, the Association have lost their work and the firm has lost its time, but if it is a success, we hope to pull our money out with a surplus after a reasonable number of years to reinvest in something else. Now the reason why we want to act in that way, is because we want to meet our obligations under the Act to do things in the public interest and balance our accounts; and secondly, if we use public money to assist one or two firms only without any *quid pro quo* we may be accused of subsidizing those firms. If, on the other hand, we pull that money out with profit in due course and reinvest in something else, then we have done our job according to the Act. What I particularly want to stress, is that in order to do our work we have got to select jobs which from both economic and technological points of view are the important ones: there is no central organization for this sort of planning, I know that it is not part of the philosophy of the government in office, but some kind of technical and economic co-ordination is needed, and that is why I am extremely grateful to Professors Carter and Williams, who have given us some valuable economic pointers.

MR. D. A. CLARK (of the Imperial Tobacco Company): As one working in industry I should like first to offer my very warmest congratulations to the authors of this Report, particularly for the amount of dead wood they have cut away. I am very glad they have made it plain that the question of taxation and the ability to expand is not nearly so simple as a good many people make out.

There are one or two points I should like to make on the Report. First, the problem of the relationship between the speed of capital expansion and the size of the firm. I believe that the large established successful firm is able to find capital for development either from its own resources or from the market more easily than the small and unproved firm can ever hope to do, which suggests that the rate of progress in a large firm, all other things being equal, is likely to be more rapid than in a great many small firms. This carries some pretty important economic and social implications. It has been said that if one wants to see examples of really spectacular progress in the United States, the way is to go along to the Anti-Trust Department of the United States Government and say, 'Who have you got your eyes on at the moment?' The second thing I should like to mention is this problem of the Capital Issues Committee and other forms of control, which somehow try to substitute for the ordinary price mechanism some kind of 'planning' view on whether money ought to be provided for this particular project. It seems to me that much of what has happened in the last ten to fifteen years has caused disillusionment in the minds of the economist and the politician on this possibility of planning and making decisions on a basis other than the profitability of what is in mind.

DR. E. G. WEST (of the Aluminium Development Association): What order of finance is being considered and what is the total overall figure now being

discussed? May I try to stimulate discussion on this aspect by reference to some general figures for the aluminium industry in this country? Total sales amounted to about £150 million in value last year and the wage bill was at least £15 million. The industry spent a minimum of £1 million on research and development activities. The amount of new capital investment by the semi-manufacturing section of the aluminium industry for improvements to its own plants, new manufacturing methods and changes required as a result of research into new channels of utilization, is more difficult to estimate, but it may average £20 to £25 million a year. Much of the research completed, and even more so, the application of its results, depends on new investment made by the customers of the aluminium industry. Thus on many occasions research and development work have shown that the adoption of a new material like aluminium will prove economic and helpful to other sections of industry; for example, public service vehicles cost less to run—but this may require the scrapping of existing equipment in these other industries. It appears that there is not enough capital to permit industry to scrap existing equipment. It has been suggested that there should be some overall guidance by a committee of industrialists or Government experts in this matter, but I do not think that this would be effective. Committees do not usually make farsighted decisions; but reach a compromise agreement which does not look as far ahead as an individual taking a risk on a new project.

A different point which seems worth making concerns the actual capital investment which is made in our scientific staffs. A graduate joining a research organization in industry is of little value for some time, and it may be two to five years before he is able to pull his full weight. During that time a great deal of capital is being invested in him, but if he decides to emigrate or if he takes a non-scientific post perhaps on the commercial side of industry quite a lot of this 'capital' may be lost, and surely this ought to be taken into account in assessing the finance required for research and development.

MR. N. G. McCULLOCH (of the British Cotton Industry Research Association): I should like to raise two points. One is a point of view of the Research Association, which I think is probably common to many of us. The Report has emphasized the importance of the relations between the board, technical director and research department, production department, finance department, sales department, and so on, and those I think who have experience in industry themselves will realize that the suitable relationships are not always to be obtained by any simple means. But in the case of the Research Association that difficulty is more complex. The subjects taken for research are selected very largely by the Director and his staff, guided by the technological experts of industry. But when the research has been accomplished and the question of its application is to be considered, the technological experts are very often not members of the board, and they are not the people who sign cheques. So there has to be a process of education of the people who do sign the cheques to persuade them that the work that has been done by the research association is one that is worthy of their attention. And in the Shirley Research Institute we have a small commercial company whose business it is to explore and exploit the work of our association. In doing that we were influenced by several reasons, but one of them was the fact that while our research was determined by the technical experts of the industry we had to find some means by which we could make our way to the board table of the various firms which were concerned. By establishing a company out of the commercial atmosphere we have achieved quite a considerable measure of success in this way. Out of the work of that company we have obtained quite a number of interesting features. One of them is the fact that, dealing very largely as we have done in instruments for quality control, the instruments devised by the staff have had a mixed reception. Some of them have been taken up with considerable success, whilst others had a less favourable reception. We do not know the reason for that as yet;

and if I might suggest it to Professor Carter, there is room for very considerable extension to the work of this report in saying what is the mind of industry with regard to these problems. Why do they accept one particular development and not another? What is the determining factor? As far as we may decide for ourselves from technical knowledge from the research angle, we are doing work which the industry requires: but in the event it does not always prove to be the case. There is room for the kind of work which I suppose could be called social science or management investigation, in order to find out what industry is really thinking, in a more detailed manner than it was done by Professor Carter. In the case of the textile industry, we have something like 1,500 to 2,000 members. If you are going to take a sufficient sector of that industry obviously it is going to cost money and time, but unless you do it on a sufficiently wide front the results will not be conclusive.

Secondly, a question. Is the work of research the kind of work which is going to retrieve the fortunes of some of our traditional industries? Is it not a fact that they are pursued by the necessity of bringing the organization of industry into a condition which meets modern views, particularly with regard to the question of shift working? Dual shift working and treble shift working have not been the practice in traditional industry in this country, but in order to make them so you have to achieve an entirely different relationship between the capital which is shown as fixed assets and that which is shown in the commercial problems of stock. That is not easily done, and it obsesses the minds of industry to the prevention of the development of research activities and the bringing of industry into a right relation with scientific problems.

MR. L. LONDON GOODMAN (of the British Electrical Development Association): I appreciate that a second One-day Conference is going to be devoted to 'Scientists and Technologists in Industry' in Leeds; nevertheless, to-day it is important to stress and restate the need for a sufficient percentage of capital expended to be spent on technological 'know-how'. Published figures of the numbers of scientists and technologists employed in various industries* do surely indicate that sufficient research on production, design, planning and related matters cannot possibly be taking place in many industries to-day.

It is impossible to give any factual generalization over the whole of industry. Nevertheless, a few examples to illustrate this state of affairs may be of interest. In some leading shipbuilding companies, for example, there are no production engineering and planning departments and no modern management organization, so that capital does not always appear to have been spent on the most efficient plant. In the cotton textile industry a new spinning mill costing about two million pounds has been built during the last few years. It was 'planned' by a director in the year before his retirement; in operation many expensive alterations have been required, *inter alia*, to the lighting, to the layout and to the materials handling, but several obstacles to efficient production cannot be removed. In a mass production plant several million pounds have been spent on new machinery and equipment, again without properly qualified personnel being employed on production research and planning in connection with it.

These examples, which it is to be hoped are not typical, can be found in all types and sizes of industry. Unfortunately, sometimes there is a prevalent idea that a high degree of mechanization, that is, high capital expenditure, is efficient. But a high degree of mechanization is usually only efficient, only really effective, when it is backed by a corresponding number of qualified engineers and scientists; the higher the degree the greater is the number required.

There is a danger which can occur particularly under the present inflationary conditions. When a business can make large savings out of high earnings due to inflation or restricted competition on account of tariff protection, it may not have

* *Scientific and Engineering Manpower in Great Britain*, H.M.S.O., 1956.

the same incentive to spend capital as carefully as if the money had to be raised in the market or under conditions of freer trade.

One final point: I should like to see far more money being devoted in industry to research on the human factor. Comparatively little money is being spent at present in individual firms on management development, management organization, human relations and on what makes the pulse of the organization beat. There is much scope for expenditure and investigations in this neglected field, and the results would prove highly productive and, dare I say? profitable.

MR. F. S. BEDFORD (of Barclays Bank, Ltd.): I represent a firm which is not clamouring for capital but one that has to say 'No' every day to those who clamour for it. I have heard many references this morning to the need for risk capital, and our last speaker has said that capital should be found for this, for that and for the other. The main problem that has to be solved is where the capital has to come from in a country that is capital-starved, particularly of venture capital. Many years ago this country built up its industrial greatness by developing ideas with the support of wealthy backers who could afford to risk a sporting chance of success. Many of those projects failed, but some of them laid the foundations for the vast industries of to-day. You then had the man with the money who could afford to 'have a go'. But the man who now commands investment resources is not the sporting backer but the Pension Fund Trustee, and it is not in the writ of the Pension Fund Trustee to 'have a go' on a sporting chance. That is one of the major problems facing British industry to-day. If you are going to develop and improve your industry to match the output of foreign competitors, then you have got to devise some system of finding risk capital in greater quantity than it is forthcoming to-day.

This is not merely an English problem. We are hearing day after day of a world shortage of capital. It seems to me that the biggest problem the economists of the world have to solve is this: the wealth of the world is greater than it has ever been before—if by wealth we mean the accessibility of raw materials and the skill and technical knowledge to exploit them for the benefit of the people on this earth—yet we have a capital shortage. This is a failure—it might possibly lead to a breakdown—of the system of money throughout the world, and unless the economists can correct it I do not see what hope there is for English or any other industry. If you are going to spread the benefits of the fruits of the world amongst the people of the world you have got to make your money system work better than it is doing to-day. On the home front perhaps there is hope in that a Commission has been appointed to investigate the working of our own money system; there may be a helpful result from that within the next year or two. But in the meantime, just as we must make do with the labour we have got, so with the capital we have available in this country. The scientific developments you wish to make are laudable, desirable, and probably carry the brightest hopes for our future, but unless as a community we can in other ways save the money that is needed to finance them you are not going to solve your problem.

MR. M. E. SIONS (of Ferranti Ltd.): I want to refer first to the recent Restrictive Trade Practices Act. In the days before the passing of this Act a company could charge a price for its products which would include provision for research, knowing that its competitors, being tied by a price ring, would not be undercutting it. Now this is improper, and it becomes more difficult to provide a certain percentage of income for research purposes. A further point I should like to make concerns the question of capital as represented in the form of patents and technical know-how. Where government departments, research associations and the like help in the financing of development and research by industry, it sometimes happens that the results of that research, in the form of patents or what is called technical know-how, are passed over to the association or government department, according to the policy

of, 'he who pays the piper calls the tune'. This, I think, is a misguided policy, because in the hands of the developing firm the patents and the industrial know-how can be put to work without fear of competition, in a way which will probably, in the long run, be more beneficial to the community than if they are in the hands of some sponsoring organization, which can only use them by way of granting licences to all and sundry to the detriment of each.

MR. M. A. L. BANKS (of British Petroleum Co., Ltd.): In this matter of how to raise capital, I should like to re-emphasize what has already been partly said by two speakers—Lord Dudley Gordon spoke of the importance of the customers in the team—Board, workpeople, shareholders, customers.

The first contributor to the discussion also spoke of the contribution made in his firm to the launching of a new product by his research and technical people, acting in the field with the sales people—if I understood his remarks correctly. Now boards provide capital when there is a sound prospect of a good sale and profit. People who buy products (customers) are of two kinds, articulate and inarticulate. An obvious example of the articulate customer is the Armed Services' demands in time of war. We can all remember the research and development efforts regarding 100 octane aviation and the radar equipment. But the main mass of customers is frequently inarticulate, and I submit that the technical man has a part to play in helping to develop market demand in line with manufacturing potential, and *vice versa*.

My point is that while the discussion has been concentrating on the things industry should or should not do about finding money for research work, the real way to do this is to create or meet customers' demands, particularly abroad; and in these days of developing technique, the research and development people have a real part to play which involves direct contact with the market.

THE CHAIRMAN: We have had a most interesting and varied discussion, and I now ask Mr. Davison to sum it up for us. Mr. Davison is the Treasurer of Courtaulds, Ltd., and thus has had considerable experience of the problems of raising capital—experience which, if all we see in the papers is true, he has recently put to very good use. He is a chartered accountant and had a varied career in industry before joining Courtaulds in 1946. He has published several papers on accounting, and has served on Committees of the Institute of Chartered Accountants, and on the Costs and Taxation and the Capital Resources Panels of the Federation of British Industries. He was also a member of the Verdon Smith Committees on the Censuses of Production and Distribution set up in 1953 by the Board of Trade. He has therefore been directly and closely concerned with the problems we have been considering this morning.

MR. E. H. DAVISON (Treasurer, Courtaulds, Ltd.): It has been very obvious this morning that the speakers have found it difficult to say something that has not already been said in the Report, and as certain members present were speaking I could see Professor Carter mentally ticking off the pages and the paragraphs in which the subjects were referred to! Now I have got down here several points; some may be relevant, some may be irrelevant. It is clear that there is a fairly general feeling that discussion on research and development projects should be joint discussion at an equal level. Three questions have to be answered in connection with any new product: can we make it? can we sell it? and will it pay? The gentlemen who have to answer those questions must answer on equal terms, speaking a common language as far as possible. A director of research is most useful provided that his co-directors can understand what he is saying and provided that he appreciates their problems, which are genuine and real although they are not susceptible to scientific measurement. The next point is the necessity for long-term planning. There have been several references this morning which bring this well to the fore. A company is a living organism, man-created, it has an indefinite life, it grows, is for a time

perhaps static, and it has to be directed and kept alive and generally shaped by the Board; that can be done only in the long term. I suggest twenty-year budgets, not because in the arithmetical sense they can be accurate, but because they do provide the framework within which to shape the company over a period of years. In the shaping of the company, of course, research and development take a very high place, and even a major project in the context of the current one or two years becomes in the twenty-year period merely a stage towards something greater: there should be long-term planning by joint discussion in a common language.

There have been references this morning to difficulty in the selection of projects. It is a difficulty that will always be with us, because we cannot work scientifically on an indefinite number of unknowns. Further, there are one or two things that I think might have been stressed in the Report and have been referred to this morning. One is the change in the private sector of savings. It is very obvious that a very high proportion of the national income is now going to people who have not the habit of saving. Any government in the general sense loves savings but detests savers and penalizes them in every possible way. There is a savings ration: up to 500 certificates you are a good chap; over 500 and you are to be punished. There is a certain illogicality in government attitudes to savings, but also there are a very large number of the working and earning population who regard saving as a 'mug's game'. Why is that? Reference has been made to the necessity for financial enlightenment. Now that to my mind is one of the strongest aids to the possibility of creating savings for research and development in industry in this country, so that the workers and employees at all levels can understand the absolute necessity of ploughing money back, of developing things which are perhaps nebulous, which may never pay, but some of which will almost certainly provide the employment and the living standards of the future. Finally, I must draw attention once again to the necessity at all costs of avoiding complacency, and to the encouragement which present-day accounting methods give to any business which has a tendency to complacency. Businesses find themselves apparently growing, apparently expanding, while all that is happening to them is that they are inflating—and the rubber is getting thinner all the time. Some reference is made to this in the book, and the professors probably quite rightly don't come down one way or the other—otherwise no doubt they would have had to write a different, and much longer book; but I must draw attention to this and I must make it clear if I can to all present how essential it is that if businesses are looking at financial matters they should look at them in a wholly realistic light and not necessarily in the light of what purports to be historical fact. They are not looking backwards, I hope.

A vote of thanks to the principal speakers was carried with acclamation. The Chairman then declared the Discussion at an end, and the Conference adjourned for the luncheon interval.

THE AFTERNOON

SECOND DISCUSSION

THE CASE OF THE SMALLER FIRM

*with Mr. A. C. Hartley, C.B.E., B.Sc., F.C.G.I., M.I.C.E., M.I.Mech.E.,
a Member of Council of the Society and Chairman of the Conference
Committee, in the Chair.*

THE CHAIRMAN: This morning we heard something of the Report and of the Science and Industry Committee, and we discussed the case of capital for scientific development for the large firm. We must now turn to the case of the small firm which wishes to finance a policy of scientific development. Firms of this kind have their own problems, and not all of them are the same as those of the bigger firm. In many ways they are in fact more difficult, and it is for that reason that we have devoted the second and the slightly longer session of the Conference to them. The discussion will be opened by Sir Nutcombe Hume; thereafter there will be a general discussion for an hour to an hour and a half, and Lord Piercy will then sum up. We hope that as many of you as can will take part in the discussion as we think this is a subject which should be looked at from as many different aspects as possible.

Sir Nutcombe Hume has had a great deal of experience in financing the smaller firm. He is Chairman and Managing Director of the Charterhouse Group, which comprises the Charterhouse Investment Trust, Ltd., the Charterhouse Finance Corporation, Ltd., and the Charterhouse Industrial Development Company, Ltd. The Group has wide interests not only in the United Kingdom, but in the Commonwealth as a whole. He is also Chairman of the Boards of several other companies, including Methuen & Co., Ltd. and Associated British Malsters, Ltd., and is on the Board of many more. He is Chairman of the National Film Finance Corporation and is Deputy Chairman of the Colonial Development Corporation. He is also a member of the Grand Council of the Federation of British Industries and a member of the Council of the British Institute of Management. He can speak from wide experience of the problems of financing development, not only of this country, but also overseas, and his views on the subject we are to discuss are based on sound practical and first-hand knowledge gained from many years of successful endeavour.

SIR NUTCOMBE HUME, K.B.E., M.C. (Chairman, the Charterhouse Group): My Charterhouse colleagues and I are flattered to find the extent to which the conclusions drawn by Professors Carter and Williams on the subject of 'Capital for Development' in Chapter 13 of their book accord with our own, which derive from over 20 years of practical experience in this field. In introducing this subject therefore I feel I can only draw attention to those aspects on which I think too much or too little emphasis has been laid.

I think the reader may be led from the context to think our authors are seeking to segregate capital for *scientific* development from that of ordinary development, and there is, I think, really no difference between the two. Intelligent development of any kind is 'scientific', particularly in any company engaged in manufacture. It cannot, I suggest, be more or less desirable to canalize capital into, say, the building and equipping of a laboratory than into another bay in the assembly shop. If development is not coordinated it is undesirable and therefore *non-scientific*.

You will notice I have just used the words 'intelligent development', and I attach much importance to the word 'intelligent'. It is, of course, only another way of saying that the persons who can apply the human quality of intelligence must be available to do so. And that is where the real shortage lies. There are all too many men in responsible managerial positions (especially in the smaller companies) who literally do not know the extent of the facilities available and their uses. This may be turning the blind eye because they believe it to be derogatory to themselves to acknowledge that someone else knows better. How often has one heard it said that a management consultant cannot possibly know more about any business than the Managing Director himself. The blind eye process is also used because getting expert advice is considered too expensive or too liable to disrupt the even tenor of the way. Again, we at Charterhouse have found how lamentably ignorant many industrialists are of the ways of the financier. He is believed to engage in some form of 'abracadabra' which results in the poor industrialist being robbed of his birthright. But perhaps even more difficult to help is the amateur financier who reads *The Financial Times* on Saturday and is indignant when it is suggested to him that he cannot raise capital on Blue Chip terms. I suggest that quite a number of good industrial businesses under competent technical management have for this reason lost the opportunity to develop.

To sum up—before the financier can help even good management to develop, an essential ingredient of that good management must be a realization that, at least in matters of finance, it must choose some reputable finance house and then trust it to do what is best for the Company.

My next point is the sources from which capital is obtainable. The minimum size of a company before it can prove attractive to the Stock Exchange and investors who seek to enjoy a free market in the securities they hold has been growing for many years, with the result that the machinery of public issue is tending to become less and less available to the smaller industrial undertaking, which still represents a very substantial part of the total activity in this country—and in the U.S.A. as well. If someone presently quotes cases of quite small companies which have sought a Stock Exchange quotation in recent months, let me say now that these operations are not normally in connection with raising capital for development and are for taxation purposes which have nothing to do with the point I am now trying to make.

Lord Piercy has told us in his recently published Chairman's remarks that I.C.F.C. had to 'close the book' to new applicants for a time as a result of application of the credit squeeze to his Company; and so, of course, had my Company and others. At that time the developing industrialist was in grave difficulty, and although it is no part of my task to-day to discuss the wisdom of the use of that method of financial control, it is only too obvious that harm could result if any artificial control method were allowed to deny new capital in a deserving case.

Our authors do not, I think, make a strong enough distinction between capital in the form of borrowed money and that in the form of share capital. Borrowed money, which is of course a debt, can prove very onerous. Anyone who can remember 1929-31 will not need me to emphasize what disaster can befall the company in debt. I should like to see much more done in teaching the industrialist that of the two alternatives of putting a millstone of debt round his neck or parting with a proportion of his equity, the latter is much more desirable and safe. There is a whole generation of men in responsible management positions to-day who have never seen bad times, or realized what angry defaulted creditors can do. I pray to Heaven that they will not see those days again, but it would be a very bold and foolish man indeed who said that it could not happen. On the whole, the Englishman is still reluctant to put himself in debt, but our friends on the other side of the Atlantic take a different view, and that always surprises me after the awful punishment they suffered in 1929-31. It is, in my opinion, a duty of all who give advice to capital raisers to

warn of the dangers of getting into debt on capital account if it can possibly be avoided. It is thoroughly bad that the incidence of Profits Tax should favour borrowing money and put such a heavy burden on ordinary share dividends.

My last point is also on the subject of taxation. Although machinery has been set up to buy capital from proprietors and thus put them in funds to meet death duties, the authors are quite right in suggesting that this problem occupies far too much of the time and energy of industrialists and their professional advisers. It does more than that, however: I am sure it is used more than it ought to be, as an argument against spending money on fixed assets for development. 'What would happen if I die before this scheme comes to fruition?' asks the Managing Director/Proprietor of a business. There is no clear-cut answer; it is probably impossible to devise any method other than a reduction of death duties, and that is unlikely to happen in the lifetime of the youngest member of this audience. If, however, life were not spiced with unanswerable conundrums of this kind, I doubt if it would be worth living.

MR. J. E. BOLTON (of the Solartron Electronic Group, Ltd.): I should like to make a few brief remarks, most of them as a result of to-day's discussion. The first is a general one; the second concerns the economical use of our resources of research and development potential; the third concerns how we might speed up the application of research and development, and the fourth how we might channel finance a better way.

First, then, whilst trying to suggest how we can be more scientific in applying research and development effort, I should like to underline my opinion that at least 10 per cent of what is needed is pure faith and at least 20 per cent is energy in application.

Secondly, if we must assume that our present resources are strictly limited in the short term, we must endeavour to make more economical use of the actual physical facilities available to us by avoiding unnecessary duplication of research effort. In industry, we tend to engage in research independently and we are all, therefore, liable to be developing similar things at the same time. Perhaps N.R.D.C. or a similar impartial body could help to collect some sort of a confidential reference library, and could give advice to industry as to what specific fields of activity are relatively virgin so far as development is concerned.

On another aspect of this problem of making more economical use of our development effort, the task could be greatly assisted if we were able to send more of our scientists to business courses, in order to help them to improve the administration of these scarce research and development resources. Most companies, including my own, put scientists at the bottom of the list when considering sending their men to executive development courses, but in the last analysis the administrative side of their work is as important as their scientific ability in determining how effectively the available development effort is applied.

Thirdly, speed in applying development: in the short term this depends on our ability to create receptive markets, which must imply a very direct partnership with potential customers. I should like to feel that it implied that customers *must* help to sponsor new developments, but that is really going a very long way. Lots of progress is being made in that direction, but one cannot help thinking that more and more could be done to underline the fact that a close mutual interest exists between the researchers and their potential customers, and that both must take part in this work of creating new products.

Finally, then, in order to improve the way in which capital for scientific development is channelled, I think we must ensure that adequate resources are directed towards the rapidly developing industries employing new techniques—such as in the automation and atomic energy fields. To do this, we must also, perhaps, revise our

method of accounting for research and development. May I suggest that if a company invests many thousands of pounds in a complex transfer machine to make a specific model of (say) a motor car, that is reasonably regarded as capital expenditure to be spread over a number of years. If it were not a capital expenditure, written off over the life of the equipment, the company would not dare to approach the project at all. This seems to be the pattern when you have industries which are in a reasonable state of old age, but with the newer industries the costs of expansion, such as the investment of capital resources in research projects, have to be written off entirely against current income because the future is uncertain. If we must endeavour to get better value for the money and for the resources that we have available, that must also involve creating better means of assessment of the future value of current research and development expenditure. As a concrete example, my own company's experience may be of interest. At the beginning of each year we have a list of several hundred potential projects, each of which has been put forward as being absolutely vital to our future. We can probably afford to carry out only five or six of these projects, so an effort is made to assess the probable cost and the probable duration of each development project; and at the same time to assess the probable sales volume in years one to five of the life of the new product, together with the probable gross margin on the sales. This sounds frightfully exact, but we know it is far from exact; but it does make us go through the exercise of asking ourselves how these things rank in our particular table of priorities. We should be much more scientific in channelling development effort if we were able to get more accurate methods of assessing the future potential of these developments. In quite normal consulting techniques to-day we are getting better and better at assessing future savings and future values—we are making nearer and nearer guesses about what is likely to happen.

I should like, therefore, to suggest that this conference would add to the value of the very excellent report from Professors Carter and Williams if it were able to recommend to the Royal Society of Arts that a follow-on study be instituted to work out more practical methods of assessing the probable future value of industrial development projects. This is a study in which I believe N.R.D.C., the accounting bodies and the Merchant Banks would be interested, because they are all vitally concerned in assessing the future in order to achieve a better use of the currently available capital resources for development.

WING COMMANDER T. R. CAVE-BROWN-CAVE, C.B.E.: If my remarks are not as severely financial as the title of the discussion I apologize, but I hope they will be appropriate to the general problem. One of the authors drew attention to the importance of dealing with fact as distinct from less definite theories. It is interesting to remember what a very large number of the most valuable inventions have come from sources which are definitely not scientific: they were indeed contrary to scientific doctrine of the time. The example which Lord Dudley Gordon has often quoted is that of Marconi, who had the effrontery to try to transmit across the Atlantic when on current scientific belief there was no possibility whatever of doing so. It was years before the Heaviside layer was invented and made the achievement scientifically respectable. There are a number of similar important discoveries which are unscientific in their origin and contrary to scientific doctrine of the time. The reason why those achievements were attempted and were successful was primarily that an individual of considerable courage made up his mind to try something he knew would be very valuable if achieved. But in modern days it is difficult to do anything like that without considerable financial backing, and that may be difficult to find. Many small firms do not know how to get in touch with people who could advise them on problems for which they have not the technical or scientific knowledge available in their own staff. I think their first line of enquiry should be to their technical college or university, because in many cases the technical knowledge which they lack is knowledge of

technical principle which the universities and technical colleges are supposed to be teaching to their students. It is also good for the teaching staff to be in touch with problems such as their students will meet later.

My last point is this. It was said this morning that every large firm, at any rate, should have a full-time scientific director responsible for research and development, and that he must be a distinguished scientist. In my own experience it is usually better that the director for whom the technical experts are waiting should be a man who knows the requirements rather than one who has great scientific knowledge, and may even dislike principles which are unconventional. Your inventor or the man who originates the idea probably has sufficient technical knowledge to keep his end up. His senior should be a man who has enough science to understand and who knows the requirements well and can see possible applications. If he is an ordinary member of the Board sharing equally the general responsibilities—and not a 'special' director—he will be best able to deal with technical advances or difficulties. He can explain their full significance and the patience and thoroughness essential for their proper treatment.

MR. NOEL JORDAN (of Ernest Race, Ltd.): This morning we found it rather difficult to arrive at an acceptable definition of a large concern, but I do not think there will be any difficulty this afternoon in arriving at an agreed definition in the case of a small firm, which could be said to be one man, who is managing director, office boy, typist, and everything else. So, if we start at that small scale I think we can go one step further and say that we might find it difficult to believe that such a concern could contribute anything worth while in the field of scientific development. It would be argued that the economic necessity of earning the daily bread would preclude scientific development, since there would be little or no time left to do so. Nevertheless, the world has every reason to be grateful to the shoemaker of Holland, for example, who developed the microscope; and I know one concern in contemporary times, a one-man concern, where the contribution towards development of fishing vessels has been most worth while. It seems to me that technical progress depends primarily on team work. First of all, you have scientific research into raw materials making available accurate information as to their complete qualities. Too often we are told about good qualities and nothing at all about the bad qualities. The second part must be first-rate technical design. This means, as I see it, the art of appreciating a problem and solving it in the most functional and economic way. The third part is limited quantity production facilities in order technically to solve methods of manufacturing. Fourthly, there is what I call pioneering salesmanship. This is an essential part of development within industry, because if true progress is to be made we must adjust ourselves to accept that progress. These facets of technical progress in industry can all be tackled by large concerns, but the progressive small concern is probably better when it comes to the design of limited quantity production. If one takes any new material—for example, one of the new synthetic resins—the possibilities of that material may influence designers in thousands of factories. It would appear possible then, for the large concern to develop the material and the small concern the technical application. What would this cost the small concern? Obviously development is costly—design, prototype manufacture, tests, selling to overcome public prejudice against the new or the different; all these, together with the inevitable troubles of going to the public with a new discovery. And there is another danger too: that of the design being copied by other concerns which may cash in on the original work. This is a very real difficulty in technical development and the protection offered by the law is inadequate at present.

The real obstacle, however, is the slow speed of accumulating reserves under our present taxation system. The small concern has a much more flexible control over the annual profit and loss figures in respect of capitalization of development than the

larger concern. This allows a yearly assessment to be made, which has the effect of decreasing the amount of tax at the expense of an untrue statement of account. That has an accumulative effect which comes to light, for example, in the event of the death of one of the main shareholders, who in most small concerns are also working directors. This is obviously fraudulent in character, but I believe it to be widespread. I think the 'ploughing back' system of financing technical development is quite obviously very much to the nation's advantage. An extended form of tax relief here would assist every concern very considerably, and, at the same time, not be unfair to other taxpayers. Professor Williams mentioned fears surrounding the small concern in raising capital for development, and I gather his attitude towards such fears is that they are more imaginary than real. He does not suggest, however, how these fears are unjustified; and I for one should like additional information on that subject.

MR. A. H. HAWORTH (of the British Tabulating Machine Company): Risk capital was mentioned this morning as being one of the most sore points. The Deputy Chairman of the Imperial Chemical Industries recently mentioned that 11 per cent had to be earned to pay 4 per cent to the shareholders. Now this means that risk capital available at 4 per cent is the result of 11 earned. So that when a company earning profits can afford to spend 11 per cent, the risk capital available as a result of that dividend payment is only 4 per cent: so it proves to me that it is uneconomic for risk capital to be used in this way. The way out of that problem is that for every £4 of risk capital invested for development purposes £7 (taxation) might be put back.

Recently when Sir Edward Appleton was speaking of his early association with Lord Rutherford, he stated that as there was no money available they had to think, and it is perhaps not a bad thing that there is not an unlimited amount of money available for development.

DR. A. C. MENZIES (of Hilger and Watts, Ltd.): I have two points: one is about human capital, and the other about financial capital. One speaker this morning spoke of the capital loss when somebody leaves a research department and goes into administration. The other facet of that, which is not at first sight connected with it, was another speaker's remark about the necessity for Directors of Research to be people who know the requirements but not necessarily scientists of distinction. The loss of one person in the research department is obvious, but the gain in communication which may be got from having somebody who has worked in a research team in sales or some other part of the organization is considerable. If you doubt this read the relevant chapter in the book. With regard to the second remark about directors of research, I think Lord Dudley Gordon was slightly misquoted because a little piece was left out. He said that the firm would gain by having a full-time executive director qualified as a scientist with wide outlook and experience responsible for policy. Now I think that when somebody attains that position he has become sufficiently mature as a scientist not to be too suspect on that score any more, and if he has been able to get to that position he will have a very lively appreciation of what is required. Such men are not the ones who produce the bright ideas; they only wish that they could have the time to study the details of problems sufficiently so as to do so, but they are the people who look after the young men who do the actual scientific work. I think that you should have somebody who is in the strictest sense an ex-scientist or ex-engineer, but if you have a person who only understands what is required then I think you are not going to have so much success.

The second point, quite disconnected from the financial one, is this: we were reminded very clearly and very well this morning that Henry VIII is dead, so that anybody who founds a college has got to found it in some other way. Applying this to our present consideration, in other words the person with the large amount of money to risk does not exist any more. The money has got to be found from Trust

funds and people like that. This is very unorthodox, no doubt, but is it conceivable and possible that there could be a sort of private company N.R.D.C.? Is it at all possible that one could have private companies existing for the purpose of investing risk capital in research, and that they could do it on such a broad scale that it would be possible for Trust funds to invest in them?

MR. M. ZVEGINTZOV (of the National Research Development Corporation): One small point of fact. I quite agree with Dr. Menzies that it might be an interesting way to finance, but we do not invest in the equity to finance production; we are there only for the development phase, and then we pull out.

PROFESSOR CARTER: It is very difficult to discover from the discussion whether you really believe that finance is the limiting factor even to the rather limited extent that we have allowed in our Report. I rather got the impression this morning that nobody was prepared to believe that large companies were ever short of money. It may be that there are some here this afternoon with more convincing examples of the continued existence of this problem. I think a little more practical experience on this matter would help us. If there is anybody here who, in his business capacity (not his personal capacity) can give us examples of development which he feels are genuinely frustrated by financial difficulties which appear to be removeable within the framework of the general national problem, it would be very helpful to hear from him.

There are one or two interesting new possibilities on the horizon, of course, in the policy statements issued by Her Majesty's Opposition. One is that there might be a time when a part of death duties would become payable in shares as a means of gradually transferring ownership to the nation. Another is the problem of the operation of giant pension funds. With the few criticisms that Sir Nutcombe Hume made, I fortunately find myself in agreement. There is one other quite unrelated thought which occurred to me, which I cannot resist the temptation to mention to you. A lot of people to-day talk about the importance of scientists, about their value either on the Board of Directors or just a little below the Board of Directors, and the need for giving the scientist the part in the direction and development of the firm which the scientifically and technically minded age requires. I cannot forbear the remark that nobody thinks economists are any use.

THE CHAIRMAN: It is now my pleasant duty to ask Lord Piercy to sum up the most interesting discussion which we have just had. Lord Piercy is well known to us and really needs no introduction. He is interested in many aspects of industry, for apart from being the Chairman of the Industrial and Commercial Finance Corporation, Ltd., he is President of the National Institute of Industrial Psychology, of the Market Research Society and of the Institution of Works Managers. This might seem to be enough for most people, but Lord Piercy also somehow or other finds time to be a Member of the Court and Senate of the University of London, and he is a Governor of the London School of Economics and of the Polytechnic. We can be sure, therefore, that his approach to the problems we have been discussing will be as wide as his own interests.

THE RIGHT HONBLE. LORD PIERCY: I feel with Professor Carter that the discussion has thrown up comparatively few points on its specific subject—the provision of development finance for small firms. Running briefly over the points that have been made, the suggestion of a non-official Research Development Corporation adequately financed by large trust funds from the part of the funds earmarked for equity investment, was interesting. I think the answer to that suggestion was given by the speaker from the N.R.D.C.: its operations would have to go farther than the N.R.D.C. itself goes. It would have to go beyond the development into the production stage, otherwise it would never get a return on its investment. That puts a rather different

complexion on the project, though this class of activity is carried on by the American Research and Development Corporation of Boston.

Mr. Haworth made the point that 11 per cent gross return on capital is only 4 per cent in payment for your risk. It would be nice if some of the 7 per cent which is taken for the benefit of our fellow citizens could be restored for development; but we must not overlook all the costs which may be charged to revenue. A somewhat analogous suggestion was made about tax on retained profits. In that connection there is a catch in the structure of the profits tax. You pay 3 per cent on profits which you retain, and this is probably believed by those who support the present structure of tax to be a great incentive to retaining profits and investing them. The catch is this: if ever, in any form, you distribute those retained profits you pay up to 27 per cent on what is distributed, so that all you really have is a temporary remission of that part of the tax. What would be really useful is a tax relief on retained profits that was a genuine remission. There is, of course, the other line of thought treated by Professor Carter in his book: inducements to investment in the form of investment allowances, generous scales for writing off expenditure out of profits, which are not changed from year to year and now knocked off and then knocked on again. That might even encourage financiers in the City to loosen their pockets for projects which at present are marginal. Then there was the question of accounting for development expenditure, treating it as a capital expenditure so as to spread the burden over a series of years. As far as I know, that is a procedure which is well known and commonly practised. It is not nearly as good as writing the expenditure off if you can; and the point which really Mr. Bolton was raising, I think, was the case of the new firm which has got an invention or innovation which involves considerable development expenditure, and comes along to Charterhouse or I.C.F.C. or other of our friends in the City, and says 'I have got something very interesting here, but I have already sunk £35,000 on it, I am at the end of my resources, I want to borrow some money. The £35,000 I have spent is genuine development expenditure and is a real asset.' If you had complete confidence that that particular invention would get through to the production stage and then make profits, you would agree that this was a capital asset, and that it was not unreasonable for the applicant to regard it as a basis for some further money. The difficulty is one of assessing the project at that precise stage.

My last point is that raised by Wing-Commander Cave-Browne-Cave. If you had a project which was, in its way, like the original Marconi project, looking pretty wild, and propounded by a man with no outstanding scientific qualifications, could he, walking round the City, get support for it? I would say that it is not completely impossible; in the past a lot of hare-brained things—like the pneumatic tyre in its day—found supporters; but I would agree that it would depend on the luck of finding some adventurous individual with ample resources. I daresay Sir Nutcombe Hume and I could think of one or two—and that would be about the extent—who might have a go.

I should like now to try to put this discussion into focus if I can. It is about the supply of finance to business concerns, and, not to use Sir Nutcombe Hume's words but to support his point, if I had been a parliamentary draughtsman I would have drawn the title more widely and not restricted it to capital for scientific development and the problems of its supply to industry. From the point of view of the practical financier, as Sir Nutcombe Hume says, development is all one and he is looking to the viability and the prospects of the business. Bearing that in mind, my next point is that providing finance is a technical job. I see that Professors Carter and Williams kindly let the financiers off as technicians; I cannot see any examination in the book of the financier as a technician. Finance as a technique must be related to the structure of the market. The financier cannot do things which the structure of the market does not permit of his doing.

That brings me to the distinction between the large and the small firm, which

I think is a perfectly valid distinction. I do not say that the small business does not develop into the large business. I can give some striking examples of the contrary from my own experience. What I am saying is that the small business is a different kind of animal from the large business, and what it really presents to you is a combination of proprietorship and control which can put a very keen edge on management. The form is mainly the private limited liability company; so that when you come to financing it you find the market problems are different. The public issue, a technique which is appropriate for large public companies, as Sir Nutcombe Hume says, is not appropriate for the small company and is becoming on the whole less so. Anyhow, it is not available for the private company. Then again, with the large company the equity usually is on the market and if new capital is wanted it may be offered in the form of equity. But with the small company the equity is not on the market; it is in the pockets of the proprietors, and it takes a lot of skill to winkle any part of it out of their pockets, and that creates quite a difficulty in financing the small company.

The problem of finding capital for the small business is peculiar in several ways. Sir Nutcombe Hume made the sound point that because of the incidence of tax and for other reasons it is getting nowadays very much into the hands of institutions, but even for an institution it is a peculiar business. You are dealing in money, you are also dealing in risk. It has been said that the banker is a specialist in doing a safe business at low rates, and he works (therefore) with a fringe of unsatisfied borrowers. Thus Professors Keynes and Paish. The institution which finances the small company is like the banker in this respect, that it will find itself working always with a fringe of unsatisfied borrowers and for much the same reason: that, in examining the request of the small business for additional capital, you must assess the risk, and it is a risk which may lie between rather narrow parallels. I was brought up to believe that the risk on any new application of capital could be met by the rate; but the fact is that is that while, say, a 6, 7 or 8 per cent risk may be acceptable, it does not follow that you will take greater risks at 10, 15 or 20 per cent. I am thinking of the supply of loan capital and preference capital. There will be a range within which the financial institution will take the risk. Outside that range it will not do the business. To try to determine the risk fairly it will apply a much more elaborate technique than the banker's; that is the financier's business. So that there is bound to be an unsatisfied demand.

Equity is a different matter. Some propositions which I could not translate into terms of fixed interest rates might strike me as acceptable ventures on a partnership basis. Participation in the equity is a partnership basis, and the financier may well decide his course by rather different tests. He may just fancy the proposition. I am not suggesting that equity solves every problem or that it is not a difficult point for the private company, being what it is. I do think, however, that it is often a good thing for growing small companies to take a partner if they can find one, some solid useful sedentary partner like Sir Nutcombe's institution or I.C.F.C.

The financing of small companies necessarily involves certain processes of investigation. They are more elaborate than the procedure applied to the case of a public company going to a public issue, although that is all very carefully done. For, if you lend money to the small company, or subscribe to its shares, without any necessary prospect as to the company's going public some day, you are married to it. It is a long-term association at the very least. And there I can echo what has been said about management. Good management is the financier's real dependence. It is important to remember that to-day it has taken on some of the aspects of a science, or at least a complex of techniques. I agree with the observations which were made on the personal qualities needed in management. Perhaps the most important quality in management ultimately is the will and determination to put the business through.

I think the \$64,000 question which Professor Carter would like answered is whether nowadays the opportunities and the facilities for the small company and the private company to obtain additional resources are adequate or not. It is very difficult to give a clean cut answer. I should be inclined to say, looking at the thing all round, that the facilities nowadays, adding in one thing and another, are not inadequate. I think it true that the small company needing finance does not always know where to go; and, paradoxically, it is rather more difficult now that there are (well-advertised) institutions than in the days when your bank manager knew somebody or your solicitor knew somebody. But I do not put that point very high. I am in some doubt as to whether a good deal more capital could be used by private companies if they took a rather broader-minded view of the terms on which it was reasonable to get it. I think if there were a greater demand the money would be forthcoming.

I will conclude by giving you some little idea of the way in which the demand for finance is probably met in practice. Here are the figures of my own concern. In ten or eleven years we have looked at 6,000 applications. Out of these, 2,000 really hardly survived the first look; but of the remaining 4,000 we have done about 800, which is about 20 per cent. I think this illustrates the principle that, especially in institutional finance, there is a certain amount you can do dependent partly upon the soundness of the proposition (the purpose in view as well as the concern itself), partly upon the terms that the borrower finds acceptable.

THE CHAIRMAN: It is my privilege on your behalf to thank Sir Nutcombe Hume for having initiated this discussion and Lord Piercy for having so concisely and adequately summed it up. It has, I think, been a most useful and stimulating discussion, and we are most grateful to them for coming here this afternoon and for helping us with their experience and wisdom to appreciate the problems which face the small firm when it wishes to adopt a policy of scientific development.

This is the end of this part of the Conference. We now look forward to the second part, on the Supply of Scientists and Technologists for Industry, to be held at Leeds on 5th July under the auspices of the British Association.

I am sure that you will all agree that to-day's proceedings have been useful and informative. We have ventilated one of the more pressing problems of modern industrial development, and if we have not found a panacea for the financial problems of industry when embarking on a policy of scientific development, we have usefully explored them, and some possible answers have been suggested. Let us hope, therefore, that practical solutions will emerge from these discussions. We have only been able to examine certain aspects of the Report. It is our sincere hope, however, that sufficient has been done here to-day to stimulate your interest in it, and that you now want to study it in more detail. If we have succeeded in that, then we have achieved our aim.

In conclusion, as Chairman of the Committee of the Royal Society of Arts which organized this Conference, I should like to thank all of you for coming here to-day and assisting in our proceedings. We realize how difficult it is, these days, for busy people to find time for all the many things they want to do, and we have been delighted that so many have been able to attend and to participate in this Conference. We have been very glad to see you and to welcome you to the Society's House, and we hope that you will come again.

A vote of thanks to Sir Nutcombe Hume and Lord Piercy was carried with acclamation, and the Conference then ended.

[The members of the Organizing Committee of the Conference were: Mr. A. C. Hartley, C.B.E., B.Sc., F.C.G.I., M.I.C.E., M.I.Mech.E. (*Chairman*); Sir Ernest Goodale, C.B.E., M.C.; and Mr. A. R. N. Roberts.

The following firms and organizations were represented:

Aero Research, Ltd.; Albright & Wilson, Ltd.; Aluminium Development Association; Barclays Bank, Ltd.; Board of Trade; British Association; British Ceramic Research Association; British Cotton Industry Research Association; British Engineers' Association; British Internal Combustion Engine Research Association; British Iron & Steel Research Association; British Petroleum Co., Ltd.; British Rayon Research Association; British Shipbuilding Research Association; British Tabulating Machine Co., Ltd.; British Welding Research Association; Building Research Station; Canada Life Assurance Co.; Charterhouse Group; Department of Scientific and Industrial Research; Dunlop Rubber Co., Ltd.; Electrical Research Association; Fairey Aviation Co., Ltd.; Ferranti, Ltd.; General Electric Co., Ltd.; Glacier Metal Co., Ltd.; Glaxo Laboratories, Ltd.; Glyn, Mills & Co.; Handley Page, Ltd.; Hayward Tyler & Co., Ltd.; High Duty Alloys, Ltd.; Imperial Chemical Industries, Ltd.; Imperial Tobacco Co., Ltd.; Ingersoll, Ltd.; Lazard Brothers & Co., Ltd.; Lloyds Bank, Ltd.; Joseph Lucas, Ltd.; Manchester College of Science and Technology; Manufacturers Life Insurance Company of Canada; Megator Pumps & Compressors, Ltd.; Ministry of Commerce, Belfast; Ministry of Supply; Morgan Crucible Co., Ltd.; National Institute of Industrial Psychology; National Physical Laboratory; National Provincial Bank, Ltd.; National Research Development Corporation; National Union of General & Municipal Workers; Norwich Union Life Insurance Society; Nuffield Foundation; Oxford University Press; Political and Economic Planning; Privy Council Office; Pye, Ltd.; Radiation, Ltd.; Albert E. Reed & Co., Ltd.; Road Research Laboratory; A. Boake, Roberts & Co., Ltd.; Science Information Service; Shell Mex & B.P., Ltd.; 'Shell' Research, Ltd.; Solartron Electronic Group, Ltd.; Sun Life Assurance Company of Canada; Texas Instruments, Ltd.; Timber Development Association; The Treasury; Ulster Office; Vickers Group Research Establishment; Westminster Bank, Ltd.; Wiggins Teape Group Research.

The following also accepted invitations to take part in the Conference:

Mr. D. P. Barritt; Miss M. I. Burnikell; Mr. J. Roger Carter; Mr. E. J. Dunstan; Mr. M. J. M. Erritt; Mr. L. Landon Goodman; Miss M. G. Hanna; Mr. J. A. Jackson; Professor H. D. Kay; Mr. Hugh Latimer; Mr. H. L. Layton; Miss D. L. Mermikides; Mr. A. P. Ravenhill; Mr. L. H. Samuels; Mr. T. W. South; Mr. J. W. Taylor; Mr. J. Thomson.]

GENERAL NOTES

THE CENTENNIAL OF CARPENTERS' HALL, PHILADELPHIA

Carpenters' Hall in Philadelphia, a pleasant Georgian building of brick with wood trimmings and cupola, this year celebrates the one hundredth anniversary of its being opened to the public as a shrine, primarily as the meeting-place of the First Continental Congress.

The Carpenters' Company of the City and County of Philadelphia was founded in 1724 'to obtain instruction in the science of architecture, to assist its members . . . and for the adoption of a system of measurement and prices'. It was closely modelled on the Worshipful Company of Carpenters of London (whose earliest paper is a renewal, dated 1133, of a royal charter of much older date). Its building, Carpenters' Hall, is one of the most important remaining structures of the old part of Philadelphia, for, first occupied on 6th September, 1773, it was the scene of the meetings of the First Continental Congress. From the City Tavern (long since demolished) George Washington, Thomas Jefferson, Benjamin Franklin and the other delegates walked to the first meeting of that Congress on 5th September, 1774. Situated at the end of 'Carpenters' Court', east of the State House, its retired position made it an ideal place in which to hold clandestine meetings.



Carpenters' Hall, Philadelphia, in Colonial times
(Lithograph by Grant M. Simon)

Christ Church, the State House (Independence Hall), Nassau Hall at Princeton, and the rather fine Georgian houses of the wealthy merchants and shipowners of Colonial Philadelphia were designed by the 'master carpenters', members of the Company, who shared the duties of the architect and the contractor of to-day. The members of the Carpenters' Company were thus responsible for much of the design and construction of the largest and best-built city in the English Colonies. It was not until the early years of the nineteenth century that professional architects, some trained in England, some in France, began to practise.

What was probably the oldest school of architecture in the United States was conducted by the Company, starting in April, 1833. The first teacher was George Strickland, brother of the architect of the Second Bank of the United States. The training consisted largely of drawing, from books in the library of the Carpenters' Company, such as *The Practical House Carpenter*, *The Carpenter's New Guide*, and James Gibbs' *Rules for Drawing the Several Parts of Architecture*.

For its first seventy-five years the Hall was rented to a variety of institutions and societies. Though Benjamin Franklin was not himself a member of the Carpenters' Company, his Library Company of Philadelphia and his 'Philosophical Society held at Philadelphia for Propagating Useful Knowledge' both rented space in the Hall; the latter in order to store a scientific apparatus. Another notable tenant was the First Bank of the United States. The Hall was finally let as auction rooms. In 1856 the Carpenters' Company rid themselves of all tenants, renovated the building, and in the following year opened it to the public as an historic shrine. The Company has now formally transferred ownership of the Hall to the Federal Government, but still holds its quarterly proceedings there.

This year the Centennial of its public status will be celebrated by a dinner meeting on 21st October, when Alan Preston, present Master of the Worshipful Company of Carpenters of London, will speak, as well as Richard Nixon, Vice-President of the United States, Pennsylvania's two Senators, Edward Martin and Joseph Clark, and the Mayor of Philadelphia, Richardson Dilworth. An anniversary plate has been made by Josiah Wedgwood and Sons, which will have as its centre a reproduction of the lithograph by Grant M. Simon of Carpenters' Hall in Colonial times.

JOHN F. HARBESON

'LANDSCAPE IN MODERN LIFE'

The first exhibition to be presented in this country by the Civic Trust, which, as announced in the *Journal* for 19th July, 1957, has been formed for the purpose of encouraging good architecture and civic design, was recently on view at Birmingham and will shortly be transferred to London. Entitled 'Landscape in Modern Life', the exhibition was originally prepared by the International Federation of Landscape Architects for their 1956 Congress in Zurich, and was subsequently shown in Lisbon and Cologne. The largest and most comprehensive display of its kind ever to be assembled, its 250 panels carry photographs, plans and drawings of the work of 16 member countries of the I.F.L.A.: Austria, Belgium, Denmark, Germany, Great Britain, Hungary, Israel, Italy, Norway, Poland, Portugal, South Africa, Sweden, Switzerland, the U.S.A. and Yugoslavia. Each panel bears explanatory notes in three languages, and the work shown includes complex schemes for green areas in large cities, plans for national parks, treatment of industrial areas and designs for municipal and private gardens.

The exhibition will be shown in the Main Foyer of The Royal Festival Hall from 2nd to 17th October, at the following times: Mondays to Fridays, 5.30 p.m. to 9.30 p.m.; Saturdays and Sundays, 1.30 p.m. to 9.30 p.m. There will be no charge for admission. The Civic Trust hopes to display the exhibition in Glasgow in November.

'THE MANAGEMENT OF DESIGN'

The Council of Industrial Design has recently published *The Management of Design*, an illustrated report on the International Design Congress held in London in September, 1956. The book is a digest of the views then expressed by more than thirty principal speakers from this country and abroad on the practical implications of three cardinal principles underlying 'the management of design'. Chapter 1, 'Implementing a Design Policy', covers responsibility at Board level, the rôle of the chief executive, working out a policy, methods and procedures. Chapter 2, 'The Rôle of the Designer', discusses his responsibilities and relations with the Board, recruitment and training, and the relative positions of consultants and staff designers. Chapter 3, 'Implications for Management', stresses the importance of team work within the firm, and its responsibilities to the public, and the need for some degree of standardization.

Copies of *The Management of Design*, price 3s. 6d. (4s. by post) may be bought from The Council of Industrial Design, 28 Haymarket, London, S.W.1.

BRITISH ADVERTISING EXHIBITION FOR EAST BERLIN

The Society of Industrial Artists have accepted an invitation to send an exhibition of the work of present-day British designers to East Berlin. Under the title of *Gebrauchsgraphik aus England* ('Advertising Art in England'), it will be held in the Exhibition Centre in East Berlin from 1st to 31st October, 1957, and is expected to tour Dresden, Bautzen, and other cities of East Germany later in the year. The exhibition will show typical work by 34 members of the Society of Industrial Artists,

and will include over 100 posters, as well as printed publicity material ranging from magazine covers to press advertisements, from record sleeves to symbols.

EXHIBITION OF ART STUDENTS' WORK

An exhibition of some of the best work produced this year for the Ministry of Education's Art Examinations may now be seen at 1, Chepstow Place, London, W.1. In addition to painting and sculpture, textiles, furniture and pottery, examples of theatre and exhibition design are shown. The exhibition is open in London until 24th September, from Mondays to Fridays inclusive, between 10 a.m. and 5 p.m., admission free. From 14th to 27th October it will be shown at the City Art Gallery, Leeds; and from 11th to 23rd November at the Bristol City Art Gallery.

NOTES ON BOOKS

MEXICAN PAINTING IN OUR TIME. By Bernard S. Myers. O.U.P., 1956. 90s

The masterpieces of European painting of the past, though often extolling a régime or potentate, hardly ever strike us as essentially instruments of political propaganda. The Venetian masters, while ostensibly commemorating the temporal power, were concerned in the first place with problems of design and luxury of colour; and though Courbet's *Funeral at Ornans*, for example, was once held to be dangerously socialistic, we can perceive that his overriding interest was in the grouping and characterization of people naturally observed in an incident of everyday life.

Nothing, indeed, can quite compare with that vehemence of propaganda which, in modern times, has equated the painting of revolutionary artists like the Mexican Orozco with the most forceful poster art. Here distorted form and emotive colour are employed by the artist with the single purpose of driving home his social 'message' with the greatest directness and punch. Certainly there is no true comparison between the colour, movement, and grandeur, let us say, of Delacroix's *Barricade*, and the strident force of Orozco's *Hidalgo y Costilla*, reproduced as a frontispiece in the absorbing volume under review. '*Après le pain*', said Danton '*l'éducation est le premier besoin du peuple*'; and in that phrase would Mexico's modern revolutionaries justify the didactic nature of their painting.

Stimulated by the Revolution of 1910, Mexican artists such as Orozco, Rivera, Siquieros, and others created, in fact, a new national expression. After describing the circumstances that led to the upheaval, Mr. Myers proceeds to discuss this Mexican cultural renaissance, placing each artist's work in focus in terms of his own artistic development and the entire movement. With the shifts of administration, the character of Mexican painting changed also, the revival of the fresco mural—officially sponsored for the purpose of influencing popular feeling—coming in the early 1920s, and supplying artists again with a common stimulus.

The author pays proper tribute to the vitality of Mexico's modern graphic art, but he admits that easel painting has only lately begun to receive some of the encouragement and patronage given so unstintingly to mural art. Already, however, Tamayo's fanciful abstractions—no less personal because they are affected by Picasso and Klee—have gained recognition in Europe and in the United States, while the work of a number of younger men holds promise for the future. Illustrated with many works of imagination and power, this survey makes a valuable addition to the Society's library.

NEVILLE WALLIS

SHORT NOTES ON OTHER BOOKS

DRAWING THE FEMALE FIGURE. *By Francis Marshal, Studio, 1957. 25s*

Number 69 in the Studio's 'How To Do It' Series is devoted to life drawing. The author illustrates his book with many litho reproductions of drawings prepared especially for it, together with selected works by other artists.

TIMES AND PLACES. *By the late Harold Peake and Herbert John Fleure. Oxford, Clarendon Press. 1956. 42s*

Based on the writers' belief that it was in south-west Asia that man made the great step from dependence on hunting to cereal cultivation and the keeping of domestic animals, this book traces the spread of food cultivation to other parts of the world. Part I of the book deals with the evolution of man, giving a broad sketch of recent work on the Old Stone Age, while Part II is devoted to the main theme of regional cultural evolution. There are 76 illustrations and maps.

RECENT ARCHÆOLOGICAL EXCAVATIONS IN BRITAIN. *Ed. by R. L. S. Bruce-Mitford. Routledge and Kegan Paul, 1956. 42s*

Contemporary field-work in archaeology in this country has not up to now been presented in book form. Here 12 authorities have provided short accounts of their excavations. Among the subjects treated are the Temple of Mithras and other excavations in the City of London, the Snettisham treasure, the Lullingstone Roman villa, and deserted medieval villages. There is a chapter on recent results of air reconnaissance. There are many half-tone plates and line illustrations.

FROM THE JOURNAL OF 1857

VOLUME V. 11th September, 1857

GAS LIGHTING IN CALCUTTA

From a letter received by The Oriental Gas Company from their managing director.

On Monday, the 6th inst., we lighted all the public lamps from Bow Bazaar, along Cassitollah, Chowringhee-road to the corner of Harrington-street, in all 55 (all lamp-posts). The success was complete, not one *contre-temps* of any kind, and we have had them lighted steadily every night since, and they now are lighted as regularly and with as little fuss as if Calcutta had had gas for 20 years, barring always the wonderment and excitement of the natives. For the first week, the crowds which paraded the streets were immense, and their conjectures as to the cause of the light were amusing. Even now, crowds assemble every evening at each end, and run along the line with the lamplighter, setting up a shout of astonishment as he applies his lantern to the burner. The commissioners are highly pleased, as are also Lord Canning and Mr. Halliday.

My own house, Prosono Coomar's house, Bodry's hotel, and F. W. Browne's are already lighted, and my servants are perfectly *au fait* at the gas lighting. Prosono had about 10,000 people in his house for the first two or three nights, gazing at the brilliancy of his lights with astonishment.